Getting to be a Successful PDR Under NPR 7120.5D

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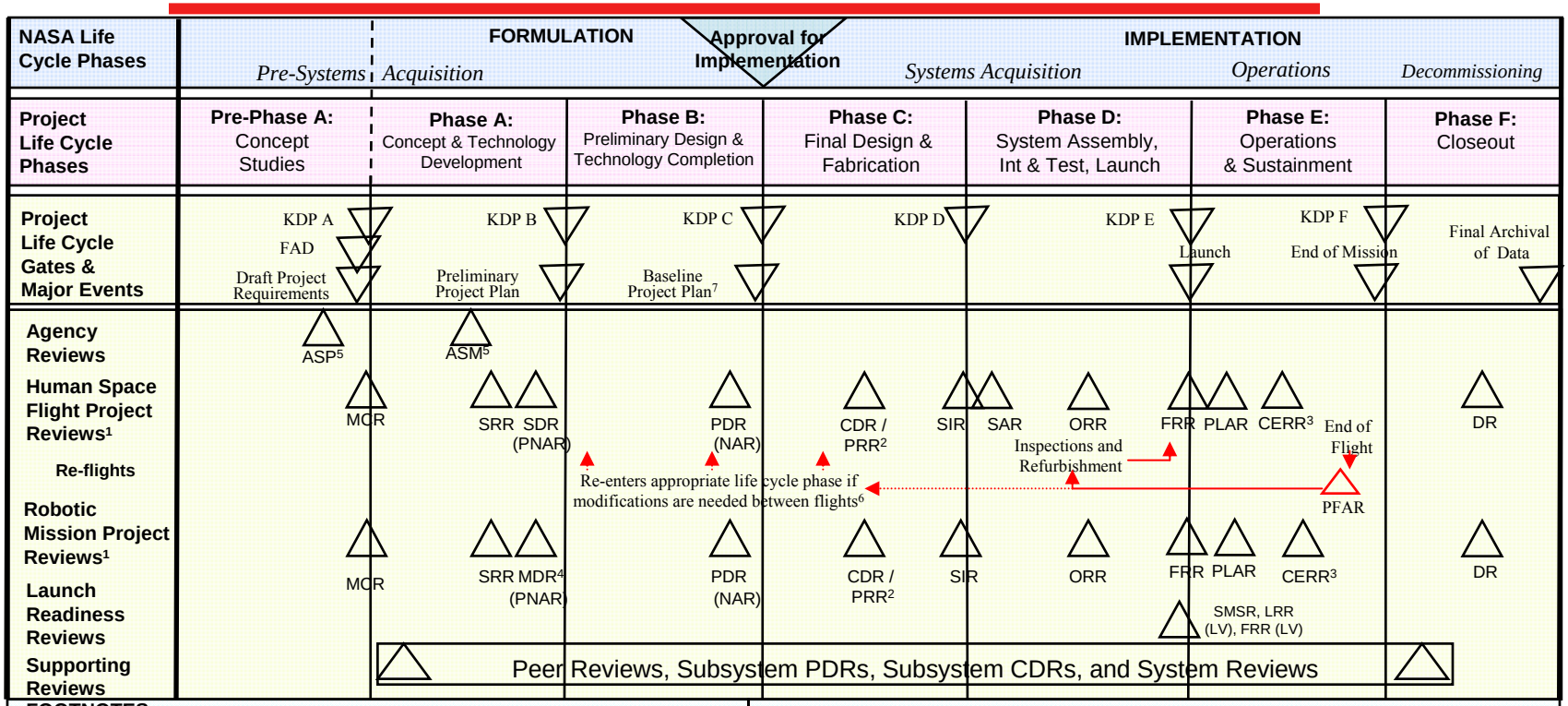
Introduction

- For purposes of this presentation, it is assumed that your project has passed Key Decision Point B (KDP B) and is now beginning Phase B
- We will first discuss NPR 7120.5D requirements and processes necessary to successfully pass PDR and KDP C, providing approval to proceed with the implementation (Phases C and D)
- We will then use examples from Juno's Phase B activities to demonstrate how you can address these requirements and processes and still accomplish the primary work necessary for a successful PDR

Space Flight Project Lifecycle



FOOTNOTES

1. Flexibility is allowed in the timing, number, and content of reviews as long as the equivalent information is provided at each KDP and the approach is fully documented in the Project Plan. These reviews are conducted by the project for the independent SRB. See Section 2.5 and Table 2-6.
2. PRR needed for multiple (≥4) system copies. Timing is notional.
3. CERRs are established at the discretion of Program Offices.
4. For robotic missions, the SRR and the MDR may be combined.
5. The ASP and ASM are Agency reviews, not life-cycle reviews.
6. Includes recertification, as required.
7. Project Plans are baselined at KDP C and are reviewed and updated as required, to ensure project content, cost, and budget remain consistent.

ACRONYMS

ASP—Acquisition Strategy Planning Meeting
ASM—Acquisition Strategy Meeting
CDR—Critical Design Review
CERR—Critical Events Readiness Review
DR—Decommissioning Review
FAD—Formulation Authorization Document
FRR—Flight Readiness Review
KDP—Key Decision Point
LRR—Launch Readiness Review
MCR—Mission Concept Review
MDR—Mission Definition Review
NAR—Non-Advocate Review
ORR—Operational Readiness Review
PDR—Preliminary Design Review
PFAR—Post-Flight Assessment Review
PLAR—Post-Launch Assessment Review
PNAR—Preliminary Non-Advocate Review
PRR—Production Readiness Review
SAR—System Acceptance Review
SDR—System Definition Review
SIR—System Integration Review
SMSR—Safety and Mission Success Review
SRR—System Requirements Review

Obtain Your Project's Categorization
(Table 2-1, NPR 7120.5D)

Request your categorization via your Program Office to the appropriate Mission Directorate at HQ

Priority Level	LCC < $250M	$250M ≤ LCC ≤ $1B	LCC > $1B, use of nuclear power source, or human space flight
High	Category 2	Category 2	Category 1
Medium	Category 3	Category 2	Category 1
Low	Category 3	Category 2	Category 1

Note: The threshold values in Table 2-1 are updated annually as part of the Agency's strategic planning guidance.

Know Your Decision Authority (DA) and Governing Program Management Council (PMC) (Table 2-2, NPR 7120.5D)

The DA is the Agency's responsible individual who authorizes the transition at a KDP to the next life-cycle phase. For Category 1 projects, the DA is the NASA Associate Administrator(AA). For Category 2 and 3 projects, the DA is the MDAA.

	Agency PMC	Mission Directorate PMC
Programs	✓	✓
Category 1 Projects	✓	✓
Category 2 Projects		✓
Category 3 Projects		✓

✓ Indicates governing PMC ✓ Indicates PMC evaluation

What is KDP C?

- The event where the DA determines the readiness of the project to progress from Phase B (Formulation) to Phase C (Implementation)
  - Life cycle phases always end with a KDP
  - The KDP is preceded by one or more reviews, including the governing PMC (see following slide)
  - Reference: Paragraph 2.4.5, NPR 7120.5D
- To support the decision process, supporting materials are presented to the DA (Reference: Paragraph 2.4.6, NPR 7120.5D)
  - Governing PMC recommendation
  - Standing Review Board Report
  - The MDAA recommendation (for Category 1 Projects)
  - Recommendations from the Program Manager and Project Manager
  - The Center Management Council (CMC)
  - Project documents that are ready for signature

Reviews Leading to KDP C
(An Example for a Category 1 Project)

- SRR/MDR (for AO driven projects)
- Inheritance Reviews
- Subsystem PDRs
- Instrument PDRs
- System level PDRs (e.g., Flight System, Mission System, Payload System, etc.)
- Project PDR
- ICAs and ICEs, and Project reconciliation
- SRB Report to CMC and Program Office, Project Response
- Brief to MDAA
- Brief to governing PMC (Agency PMC)
- Agency PMC recommendation to Decision Authority (NASA AA)
- DA makes KDP C decision

KDP C Criteria

- The DA considers a number of factors:
  - Relevance to Agency strategic needs, goals and objectives
  - Continued cost affordability wrt the Agency's resources
  - Project's viability and readiness to proceed to the next phase
  - Remaining project risk (cost, schedule, technical, management and safety)
- For Projects going to KDP C, the PDR independent life cycle review is conducted by the Standing Review Board (SRB) using the following criteria (Ref: paragraph 2.5.2.1, NPR 7120.5D):
  - Alignment with and contributing to Agency needs, goals and objectives
  - Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria (and Center standards)
  - Adequacy of schedule
  - Adequacy of estimated costs, including Independent Cost Analyses (ICAs) and Independent Cost Estimates (ICEs), against approved budget resources
  - Adequacy/availability of resources other than budget
  - Adequacy of risk management approach and risk ID/mitigation
  - Adequacy of management approach

Shouldn't be anything new here!

Independent Life Cycle Reviews

- Independent life cycle reviews may or may not precede the KDPs (in our case, the PDR is such a review that precedes KDP C). Ref: paragraph 2.5 of NPR 7120.5D
  - These reviews are conducted by an SRB, under documented Agency and Center review processes
  - Projects document in their Project Plans their approach to conducting internal reviews and how they will support the independent life cycle reviews
- Terms of Reference (ToR) for each independent life cycle review
  - Approval and concurrence depends on Project Category
  - For instance, Category 1 Projects include approval of the NASA AA, MDAA, NASA CE (concur), Center Director, and AA for PA&E
  - Contains review success criteria, SRB membership, etc.

Standing Review Board

- The SRB's role is advisory to the project and convening authorities
  - SRB does not have authority over any project content
  - Should offer recommendations to improve performance and/or reduce risk
  - Its outputs are briefed to the project under review prior to being reported to higher level management
- SRB Membership
  - Chairperson
  - Review Manager (from PA&E or Technical Authority, depending on Project category)
  - Members responsible for ICAs and ICEs (may be IPAO provided)
  - Chair organizes SRB and submits names of proposed members to the convening authority for approval
  - Board members must be independent of the project, and some members must be independent of the project's Center

Phase B Activities Guidance

- Paragraph 4.5 of NPR 7120.5D provides specific guidance regarding Phase B activities
- Required activities include
  - Support HQ and program related activities such as
    - Launch vehicle selection
    - Baseline program requirements on the project (i.e., Level 1 requirements and mission success criteria)
  - Perform Technical Activities such as
    - System, sub-system and lower level requirements generation
    - Preliminary design
    - Baseline mission operations concept
  - Perform project planning, costing and scheduling activities such as
    - Generation of the integrated baseline
    - Preparations for implementation of earned value requirements
    - Life cycle cost estimates, including reserves

Phase B Activities Guidance (cont'd)

Tables 4-3 and 4-4 of NPR 7120.5 D provide guidance on required gate products (with maturity level) and project control plans, respectively, required for KDP C

Products	Pre-Phase A KDP A	Phase A§ KDP B	Phase B KDP C	Phase C KDP D	Phase D KDP E	Phase E KDP F
Headquarters and Program Products						
1. FAD	Approved					
2. Program Requirements on the Project (from the Program Plan)	Draft	Baseline	Update			
3. ASM minutes		Baseline				
4. NEPA compliance documentation			Environmental Assessment or Environmental Impact Statement (if required) *			
5. Interagency & International Agreements			Baseline			
Project Technical Products						
1. Mission Concept Report	Preliminary	Baseline				
2. System Level Requirements		Preliminary	Baseline			
3. Preliminary Design Report			Baseline			
4. Missions Operations Concept		Preliminary	Baseline			
5. Technology Readiness Assessment Report			Baseline			
6. Missile System Pre-Launch Safety Package			Preliminary	Baseline	Update	
7. Detailed Design Report				Baseline		
8. As-built Hardware and Software Documentation					Baseline	
9. Verification and Validation Report					Baseline	
10. Operations Handbook				Preliminary	Baseline	
11. Orbital Debris Assessment		Initial	Preliminary	Baseline		
12. Mission Report						Final
Project Planning, Cost, and Schedule Products						
1. Work Agreements for next phase		Baseline**	Baseline	Baseline	Baseline	Baseline
2. Integrated Baseline	Draft	Preliminary	Baseline			
3. Project Plan		Preliminary	Baseline			
4. CADRe		Preliminary	Baseline	Update		Update
5. Planetary Protection Plan		Planetary Protection Certification	Baseline			
6. Nuclear Safety Launch Approval Plan		Baseline (mission has nuclear materials)				
7. Business Case Analysis for Infrastructure		Preliminary	Baseline			
8. Range Safety Risk Management Plan			Preliminary	Baseline		
9. Systems Decommissioning/Disposal Plan				Preliminary		Baseline
KDP Readiness Products						
1. Standing Review Board Report (SRB)	Final	Final	Final	Final	Final	Final
2. Project Manager Recommendation (includes response to SRB Report, as applicable)	Final	Final	Final	Final	Final	Final
3. CMC Recommendation	Final	Final	Final	Final	Final	Final
4. Program Manager Recommendation	Final	Final	Final	Final	Final	Final
5. MD-PMC Recommendation (for Category I projects only)	Final	Final	Final	Final	Final	Final
6. Governing PMC Recommendation	Final	Final	Final	Final	Final	Final

* See Section 4.5.2 a. (2) for exceptions.

§ See footnote 15 in Section 4.4 for competed mission exceptions

NPR 7120.5D Project Plan - Control Plans	Pre-Phase A KDP A	Phase A KDP B	Phase B KDP C	Phase C KDP D	Phase D KDP E	Phase E KDP F
1. Technical, Schedule, and Cost Control Plan		Preliminary	Baseline			
2. Safety and Mission Assurance Plan		Preliminary	Baseline			
3. Risk Management Plan		Preliminary	Baseline			
4. Acquistion Plan		Preliminary	Baseline			
5. Technology Development Plan		Baseline				
6. Systems Engineering Management Plan		Baseline				
7. Software Management Plan		Preliminary	Baseline			
8. Review Plan		Preliminary	Baseline			
9. Missions Operations Plan			Preliminary	Baseline		
10. Environmental Management Plan		Baseline				
11. Logistics Plan		Preliminary		Baseline		
12. Science Data Management Plan			Preliminary	Baseline		
13. Information and Configuration Management Plan		Preliminary	Baseline			
14. Security Plan		Preliminary	Baseline			
15. Export Control Plan		Preliminary	Baseline			

Juno Phase B Activities

- So now that we've briefly explored NPR 7120.5D's rules of engagement for Phase B activities leading up to and including KDP C, let's take a look at how the Juno Project is addressing some of these areas
- The following slides are an excerpt of a presentation given to NASA SMD in November 2006
- As a way of introduction, it is the PM's assertion that Phase B activities are focused upon risk reduction in order to show at KDP C that the project has adequate cost, schedule and technical resources to get the job done, with appropriate margin ⇒ the project has a low risk posture
  - These activities also ensure your preliminary design will mature and that the appropriate gate products for KDP C are generated

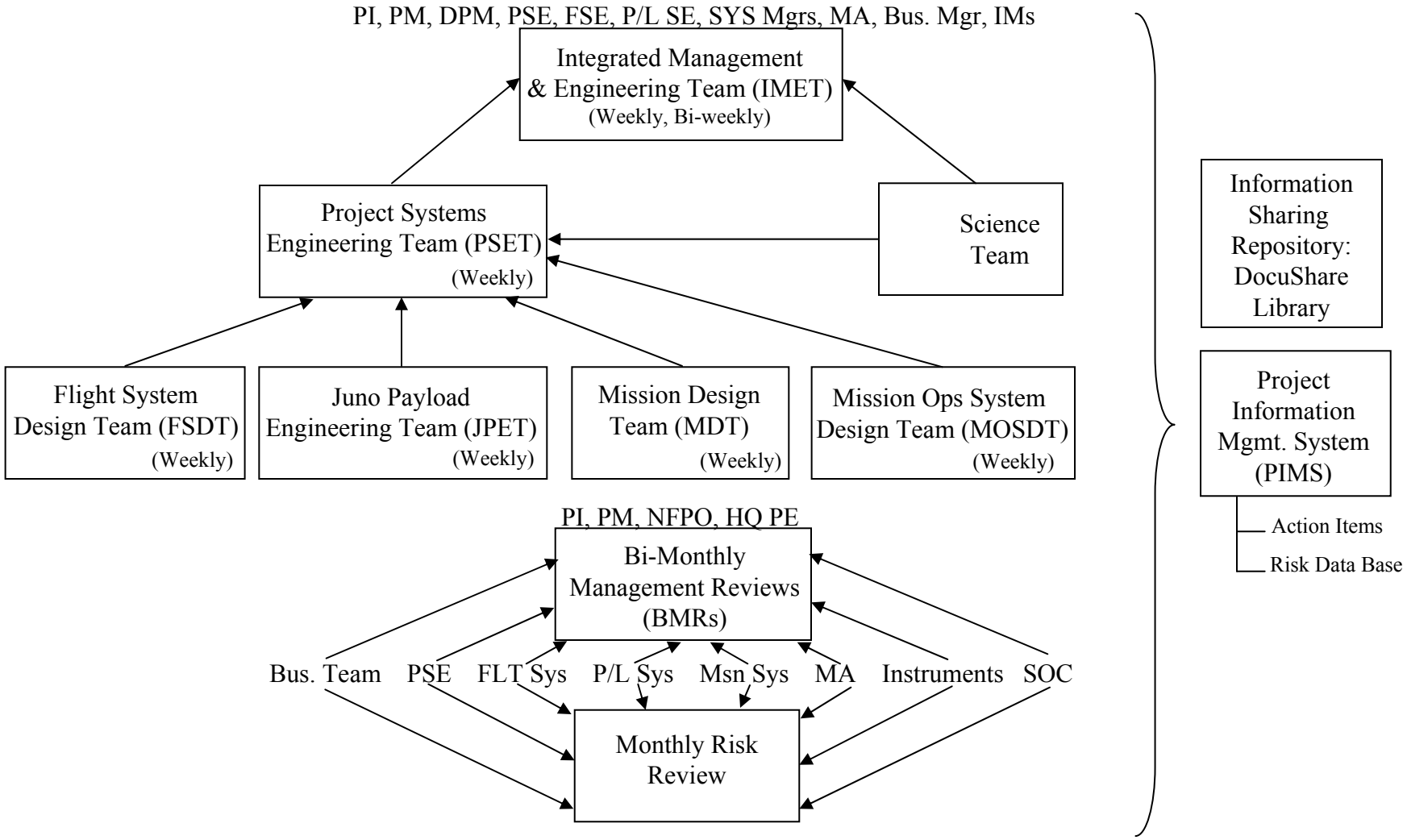
Risk Reduction in Phase B

- The next section deals with risk reduction activities addressed in Phase B, both nominal and those added to take advantage of the extended Phase B
  - This is not a comprehensive list of all Phase B activities, but is representative of the work being accomplished
- The content is as follows:
  - High Level Risk Mitigation approaches
    - Communications
    - Cultural Differences and Expectation Mismatches
  - Risk Mitigation approaches in key areas
    - Requirements
    - Inheritance
    - Operational Environments
    - Science Instrument Developments
    - Mission Operations
    - Margins/Reserves
  - Specific Activities
    - Key Trade Studies
    - Key Technical Risks
    - Examples of specific risk reduction activities
  - Cost Estimates & EVMS

Communications

- Risk: Complex organization and multiple interfaces result in lack of communications and miscommunications
- Activities
  - Integrated Management and Engineering Team (IMET)
  - Project Systems Engineering Team (PSET)
  - Individual System Engineering and Management Teams
  - Bi-Monthly Management Review (BMR, every two weeks)
  - Risk Management process
  - Data Management
- Indicators: Project's command, control and communications (C^3) functions up and running at full speed
- See following slide

Engineering & Management Team's Meeting Structure



Requirements

- Risk: Requirements are not well defined or understood in Phase B
- Activities:
  - Early requirements definition (with rationale) and flow down to identify key, driving requirements at subsystem level
  - Significant involvement of science community to understand science requirements rationale and implementation consequences
  - Identify and resolve key project system trades
  - Identify requirements unnecessarily driving the design or driving designs away from inheritance
  - Early definition of mission operations concept in order to drive out hidden requirements
- Indicators:
  - Juno PLR (Level 1 requirements) draft already generated & in coordination
  - Lower level requirements already very close to PMSR level
  - Trades identified and being worked
  - Capability and Requirements Review (CRR)
  - Requirements maturity at PMSR and PDR

Inheritance

- Risk: Overly optimistic assumptions regarding level of inheritance and obsolescence issues (due to 2 year delay), result in significant increased development, analyses and test costs
- Activities:
  - Identify potential parts/material obsolescence and procure early
  - Early identification of requirements driving design changes and pushing back
  - Robust inheritance review process across all systems prior to PDR
- Indicators:
  - Early procurements of FPGAs, Li-ion battery materials, telecom Small Deep Space Transponder (SDST)
  - Process in place to continually monitor for other obsolescence issues
  - CRR addressed early look at inheritance issues and requirements driving changes to inheritance
  - Inheritance review schedule (see Reviews Schedule)

Mission Operations Planning

- Risk: Mission operations planning is not synchronous with the rest of project planning in Phase B, resulting in poor operability and hidden costs that don't become evident until Phase D
- Activities:
  - Mission phase scenarios working group to identify additional requirements and ensure operability
  - Early generation and review of operations concept
  - Participation in Level 2 requirements working groups
  - Identification of critical operations trades
  - Early definition of key interfaces with, and requirements upon, JSOC
- Indicators:
  - Integrated schedule synchronized with flight system activities
  - Detailed Phase C/D/E grass roots cost estimates
  - Resolution of MOS/GDS trades
  - Identification of unique issues associated with length of mission

Understanding Margins

- Risk: If you simply follow the margin guidelines (technical, cost and schedule) and think you are fine at this early stage, you will be in trouble in Phase C/D (if not at PDR)
- Activities:
  - Complete critical trades early and assess impacts to margins
  - Retire key risks early and assess impacts to margins
  - Create a system to track opportunities as well as threats to all margins and report frequently
  - Implement strong risk management process
- Indicators:
  - Schedule workshops to understand critical path and margins
  - All margins reported every other week at BMRs
  - Risk Management system and process in place
  - CRR results used to reassess schedule margins and budget reserve posture
  - Early Phase C/D grass roots estimates
  - Project's budget reserve and schedule margin exceeds guidelines in almost all areas

Phase C/D Cost Estimates

- Risk: Phase C/D/E grass roots estimates delivered late in formulation (just prior to PDR) and inadequate integrated financial/schedule system in place for Phase C/D
- Actions:
  - Early grass roots cost exercise 11/06 through 05/07, including the system contractor
  - Second grass roots cost exercise begins 8 months before PDR
  - System contractor final Phase C/D proposal due 4 months prior to PDR (typically it's been 1 month)
  - Developing integrated plan for CADRe, IBR and Earned Value implementation to support PDR, NAR and Confirmation Review
- Indicators:
  - Early grass roots exercise currently in progress
  - Integrated schedule for CADRe, IBR and EV implementation (see following slide)
  - Lockheed Martin already taking earned value on selected Phase B tasks

DRAFT
EVMS Implementation Plan - Phase C/D

- Full EVMS criteria will apply to LM, JPL, and instruments where applicable once we move into Phase C/D
- "Preliminary" IBR, ICE and NAR window planned between 4/08 – 8/08
  - Why Preliminary IBR?
    - Costing currently will begin 8 to 10 months prior to PDR – any earlier would drive greater likelihood of inaccuracies in the baseline plan.
    - CADRe isn't available until 4/13/08, PDR planned for 5/13/08.
    - Must allow time for final costing of flight system and instruments, fact finding, technical evaluation, and negotiation of LM Phase C/D contract prior to final baseline being set.
      - These activities may change the preliminary EVMS baseline.
    - This baselining activity is planned to happen concurrently with PDR activities at the system and instrument levels – very busy time.
- "Final" or formal IBR window planned for 9/08 – 11/08
    - Based on 60 days to establish formal baseline after KDP-C and allowing 1 to 2 months of reporting against formal EVMS baseline

Summary

- Navigating NPR 7120.5D can appear difficult, but hopefully this presentation makes it easier
  - Similar guidance in the NPR for other life cycle phases
- The NPR is not so onerous that you can't get the "real work" done
- Your project planning needs to account for the additional reviews leading to any of the KDPs